DOCUMENT RESUME

ED 475 942 IR 021 940

AUTHOR	Mills, Steven C.; Tincher, Robert C.
TITLE	Be the Technology: Redefining Technology Integration in Classrooms.
PUB DATE	2002-06-00
NOTE	19p.; In: NECC 2002: National Educational Computing Conference Proceedings (23rd, San Antonio, Texas, June 17-19, 2002) see IR 021 916.
AVAILABLE FROM	For full text: http://confreg.uoregon.edu/necc2002/ .
PUB TYPE	Reports - Research (143) -- Speeches/Meeting Papers (150)
EDRS PRICE	EDRS Price MF01/PC01 Plus Postage.
DESCRIPTORS	*Computer Assisted Instruction; Computer Uses in Education; Curriculum Development; Educational Development; *Educational Technology; *Professional Development; Program Evaluation; Standards; Teaching Models; *Technology Integration
IDENTIFIERS	*Technology Implementation

ABSTRACT

A technology professional development initiative was launched in a school district with the goal of extending technology use in the classroom. For teachers to teach expertly, the aim was for them to "be the technology" by modeling technology use in the classroom, applying technology across the curriculum, applying technology to problem-solving and decision-making activities, and applying technology to facilitate collaboration and cooperation among learners. To implement this technology initiative, a set of technology standards and indicators was established to describe best practices for expert teaching and student learning using technology. It was that hypothesized teachers would experience several stages as they developed into expert technology integrators and that this technology initiative could be evaluated by tracking their progress through these stages. This study analyzes the developmental model for technology integration based on the stages, standards, and indicators of the technology professional development initiative and validates its use as a tool for use in the evaluation of technology integration. (Contains 12 references, 3 tables, and 2 figures.) (Author)

BE THE TECHNOLOGY: REDEFINING TECHNOLOGY INTEGRATION IN CLASSROOMS

Steven C. Mills, Ph.D.
The University of Kansas
Institute for Life Span Studies
2601 Gabriel
Parsons, KS 67357
620.421.6550 X1735
stevem@ku.edu

Robert C. Tincher
Independence Unified School District
403 W. Oak Street
Independence, KS 67301
620.332.1813
btincher@indyschools.com

ABSTRACT

We launched a technology professional development initiative in a school district with the goal of extending technology use in the classroom. For teachers to teach expertly we wanted them to "be the technology" by modeling technology use in the classroom, applying technology across the curriculum, applying technology to problem-solving and decision-making activities, and applying technology to facilitate collaboration and cooperation among learners. To implement this technology initiative, we established a set of technology standards and indicators to describe best practices for expert teaching and student learning using technology. We hypothesized teachers would experience several stages as they developed into expert technology integrators and that we could evaluate this technology initiative by tracking their progress through these stages. This study analyzed our developmental model for technology integration based on the stages, standards, and indicators of our technology professional development initiative and validated its use as a tool for use in the evaluation of technology integration.

KEY WORDS: Technology Integration, Technology Standards, Professional Development, Program Evaluation, Educational Change

For computer technology to recreate or reorganize the learning environment—what we call *technology integration*—computers and technology must be viewed in terms of function rather than application, process rather than approach (Becker, 1994; Hadley & Sheingold, 1993). Over a decade ago Sheingold (1990) pointed out that integrating technology in schools and classrooms is not so much about helping people to operate machines as it is about helping teachers integrate technology as a tool for learning. Our own evaluations of technology integration in classrooms have led us to conclude that technology integration in classrooms is more about teaching and learning than it is about technology. The potential for technology use in the classroom extends far beyond being a mere teaching tool—we could say that for teachers to teach expertly they must "be the technology!"

According to Sandholtz, Ringstaff, and Dwyer (1997), technology integration includes five stages: entry, adoption, adaptation, appropriation, and invention. Entry stage teachers use text-based materials and instruction to support teacher-directed activities. Adoption stage teachers use technology for keyboarding, word-processing, or drill-and-practice software. Adaptation phase teachers integrate new technologies into classroom practice and students use word processors, databases, graphic programs, and computer-assisted instruction. Appropriation stage teachers begin to understand the usefulness of technology and students work at computers frequently as project-based instruction begins to take place. In the invention stage learning becomes more student-centered as multi-disciplinary, project-based instruction, peer tutoring, and individually paced instruction occur.

Hadley and Sheingold (1993) analyzed patterns of technology used by teachers and proposed multiple profiles for technology integration based on five teacher segments: enthusiastic beginners, supported integrators, high school naturals, unsupported achievers, struggling aspirers. Using a national survey, Becker (1994) identified exemplary computer-using teachers and the characteristics that distinguished them from other computer-using teachers. Becker determined that exemplary computer-using teachers had no distinct advantages over other computer-using teachers as far as resources or student achievement or abilities were concerned, but they taught in an environment that helped them become better computer-using teachers. They had prepared themselves better to use computers in their teaching, and they had allowed technology to have an impact on how and what they taught.

We launched a technology professional development initiative in a school district with the goal of revolutionizing classroom teaching practices that create learning environments capable of preparing a new generation of learners for a 21st century workplace driven by the acquisition and manipulation of information. To implement our technology professional development initiative, we established a set of technology standards and indicators that clearly described a set of educational best practices for expert teaching and student learning with technology as the foundation and framework of this initiative. Since there is a high degree of variability in educational beliefs, technological availability, and state and community expectations, technology integration should be locally defined, using available research models and national standards as a foundation (Pierson, 2001; Hadley & Sheingold, 1993). Therefore, we formulated a set of standards for our own educational context by combining local, state, and national technology standards and then identifying educational best practices to support our standards.

The purpose of this study was to appraise the value of the technology professional development initiative by validating the technology integration standards and stages identified by our technology professional development model and by evaluating the progress of teachers through these stages. We hypothesized teachers would experience stages of development to become expert technology integrators. Therefore, we organized these standards into *phases* to reflect a developmental approach from novice technology operators, who use technology as a tool for professional productivity, to technology facilitators, who use technology as a tool for the delivery of instruction, to expert technology integrators, who are *being the technology*—augmenting student learning with technology. Furthermore, we postulated that if the phases of technology integration we devised reasonably reflected the reality of technology integration in classrooms, then the technology integration knowledge and skills of teachers could be identified and described in terms of these developmental stages. We could then measure their progress through the stages and use these measurements to gauge the relative effectiveness and value of the technology initiative.

A number of interventions were provided to support and reinforce this *be the technology* professional development model. We started by offering a summer technology institute, workshops, seminars, and college-credit courses. We devised a set of performance assessments whereby teachers could demonstrate their technology integration expertise for each of the developmental phases. Financial incentives and credentialing were provided to teachers who demonstrated technology integration knowledge and skills based on performance assessments. These performance assessments corresponded with each phase and required teachers to model the technology integration knowledge and skills promulgated by the technology professional development model. As the number of teachers certifying their knowledge and skills at each of the phases increased, they teamed with peers and numerous informal small-group, mentoring, and tutoring sessions organized in schools, departments, and grade-levels throughout the district.

Technology Integration as a Model for Educational Change

The goal of transforming teaching and learning by increasing access to and use of technology in schools and classrooms has been near the top of most educational reform agendas since the early 1980s (Cuban, 2001). The integration of technology in classrooms and schools, however, is a complex process that entails supporting curriculum goals through the instructional use of computer technology to enhance student learning (Dockstader, 1999). To deal with this complexity, educational change models often attempt to assess and explain the change process in terms of dimensions or degrees of change.

Several models or strategies have been employed by educational researchers and practitioners to provide a systematic approach for determining the quality of innovation implementation. Since we perceived technology integration to be a developmental process, the Concerns-Based Adoption Model (Hall, Wallace & Dossett, 1973) fit our evaluation requirements because it emphasized change as a developmental process experienced by individuals implementing innovations within an organizational context. CBAM represents a comprehensive systemic change model that allows change investigators and facilitators to understand organizational change from the point of view of the persons affected by the change (Surry, 1997). CBAM is based on the assumption that change is best understood when it is expressed in functional terms—what persons actually do who are involved in the change. CBAM provides for the development of diagnostic tools based on the design of the innovation being evaluated. One of these diagnostic tools is the Innovation Configuration Matrix or Map (ICM), which represents an innovation in the form of a two-dimensional matrix with the various configuration components along one dimension of the matrix and a scale that renders closer approximations of implementation or use along the other dimension of the matrix.

Since the ICM has a procedural rather than static definition, it accommodates the evaluation of innovations (such as technology integration) that are changeable or variable over time and across contexts while employing a fixed evaluation protocol. Therefore, we formulated an ICM, the *Technology Integration Standards Configuration Matrix* (*TISCM*), based on the developmental stages, standards, and indicators of our technology professional development model as a tool for use in the evaluation of technology integration among teachers in the district.

METHODS

Instrumentation

The *Technology Integration Standards Configuration Matrix* (*TISCM*) was formulated based on a consensus-building process that followed a procedure developed by Heck, Steigelbauer, Hall, and Loucks. (1981) and used previously by the researchers (Mills, 2001-2002; Mills & Ragan, 2000). Relevant national, state, and local technology standards were reviewed and evaluated by the researchers in conjunction with the district technology committee. The committee reached consensus on 18 technology integration standards that were appropriate for the school district.

Technology integration standards were organized into three skill sets or phases: *Phase 1—Using Technology as a Tool for Professional Productivity* (Standards 1-6), *Phase 2—Facilitating and Delivering Instruction Using Technology* (Standards 7-12), and *Phase 3—Integrating Technology into Student Learning* (Standards 13-18). Each successive phase was intended to identify a set of instructional strategies that exemplified a more appropriate use of technology for facilitating or enhancing student learning in the classroom along a continuum from technology as a tool for professional productivity (Phase 1) to technology as a tool for the delivery of instruction (Phase 2) and ultimately to the establishment of learning environments where student learning is augmented by technology (Phase 3).

Each technology standard was designated to be a component for one dimension of the matrix. For the other dimension of the matrix, variations for each component or technology standard were identified. These variations described specific classroom teaching practices using technology. The variations for each component were organized along a continuum from unacceptable use to ideal use. For example, in determining variations for the component, *Use Software Productivity Tools*, creating a simple document using word processing was construed to be minimal use while merging word processing and spreadsheet objects to create a report was construed to be ideal use. The component variations were refined by the researchers in consultation with the technology committee to reflect actual practices of teachers integrating technology in classrooms.

The components and component variations were organized into a matrix comprised of four variations for each of the 18 components with each successive variation indicating a level of use representing a closer approximation of ideal use and/or technology integration. A checklist corresponding to the components and variations on the *TISCM* was devised as a self-report instrument to be completed by teachers using paper- or Web-based administration.

Subjects and Procedures

The school district used in this study was located in a small town in a Midwestern state. The school district had a total enrollment of almost 2,200 students in grades K-12 with 147 certified teachers. Computer technology was used in all the schools in the district. All schools, except the high school, had computer labs and all teachers had classroom computers.

The school district had made a substantial investment in computer technology and was beginning a district-wide technology professional development initiative.

To collect baseline data regarding technology integration occurring in classrooms, all teachers at all grade levels were provided with a paper version of the *TISCM* checklist and the option to complete a Web-based version of the *TISCM* checklist on the school district Web site. Only a Web-based version of the checklist was used for the end of year administration. The checklist was designed in a multiple-selection format in which respondents could select more than one response for each *TISCM* component. Data collection occurred at both the start and end of a school year. A usable *TISCM* checklist was completed by 70 teachers at the start of the school year and 78 teachers at the end of the school year and 46 teachers completed both the start and end of year administration of the *TISCM* checklist.

Several statistical methods were used to evaluate teacher responses to the start and end of year *TISCM* checklists. Discriminant analysis validated the classification of cases into different groups and determined which *TISCM* components discriminated among the groups. Frequency counts for the *TISCM* checklist responses for the start and end of year administrations were examined to determine the attributes of each configuration pattern group based on the *TISCM* components and phases. Results from the end of year *TISCM* checklist administration were compared with a matched set from the start of year administration using a paired-samples t-test in order to measure significant change in the development of technology integration expertise among the teachers in the school district.

RESULTS AND DISCUSSION

Descriptive statistics for the start and end of year data collections were computed and are provided in Table 1. Reliability statistics were computed on both the start and end of year data collections to determine the internal consistency of the *TISCM* checklist. The final 18-item checklist allowed for a range of total scores from 0 to 72. The *TISCM* checklist yielded a coefficient alpha of .91 for the start of year administration and .89 for the end of year administration.

Table 1. Descriptive Statistics for Start/End of Year Administration of *TISCM* checklist.

	Start of Year (N=70)			End of Year (N=78)		
TECHNOLOGY STANDARD	**SUM**	**MEAN**	**SD**	**SUM**	**MEAN**	**SD**
1. Operate common technology input devices.	217	3.10	.82	313	3.73	.73
2. Perform basic file management tasks.	206	2.94	1.11	316	3.76	.63
3. Apply trouble-shooting strategies and install software.	226	3.23	.87	318	3.79	.70
4. Use software productivity tools.	182	2.60	1.34	297	3.54	1.01
5. Use technology to communicate and collaborate.	228	3.26	.72	316	3.76	.59
6. Use technology to collect data and perform research.	188	2.69	1.10	286	3.40	.95
7. Model responsible use of technology.	174	2.49	1.42	274	3.26	1.13
8. Facilitate regular student use of computer technology.	208	2.97	1.45	257	3.06	1.43
9. Conduct learning activities using computer technology.	187	2.67	1.43	234	2.79	1.46
10. Select appropriate technology resources for classroom use.	83	1.19	1.33	194	2.31	1.69
11. Evaluate the validity of data collected using technology.	22	.31	.91	93	1.11	1.69
12. Use technology to present classroom instruction.	154	2.20	1.16	235	2.80	1.23
13. Integrate technology-based learning experiences into classroom instruction.	138	1.97	1.43	207	2.46	1.48
14. Use computer technology for problem-solving and critical thinking.	118	1.69	1.48	199	2.37	1.48
15. Use technology to facilitate individualized/cooperative learning experiences.	94	1.34	1.39	157	1.87	1.40
16. Assess student use of technology using multiple methods of evaluation.	66	.94	1.57	91	1.08	1.53
17. Develop and maintain electronic student portfolios.	23	.33	.88	48	.57	1.01
18. Use computer technology to maintain and analyze student performance.	136	1.94	1.23	224	2.67	1.08

<u>Beginning of Year Data Collection</u>

Since the initial cluster centers and the number of dominant patterns were unknown, cluster analysis was performed on the first administration of the *TISCM* checklist using all 18 technology standards or components of the *TISCM* and incrementing the number of clusters until a reasonable model was obtained. The cluster analysis was run for 2, 3, 4, and 5 clusters before a reasonable model was selected. A reasonable model occurred with the number of clusters set at

3. When the number of clusters was set at 3, the number of cases in Group 1 was 21, Group 2 was 33, and Group 3 was 16. To make comparisons between the start and end of year data, the same grouping model (3 groups) was used for analysis of the end of year data collection.

The start of year configuration pattern groups were entered into a Discriminant Analysis (DA) to determine which *TISCM* components discriminated among the groups and to validate the classification of cases into different groups. Using this procedure enabled the researchers to better describe the characteristics and define the differences among the configuration pattern groups. The *TISCM* components were loaded into the DA as the independent variables using a model where they were all entered simultaneously to force the DA to consider the contribution of all components to the discrimination among groups. As a result of this procedure 96% of the cases or 67 of 70 cases were correctly classified. The DA predicted 1 case in Group 2 for Group 1, 1 case in Group 2 for Group 3, and 1 case in Group 3 for Group 2.

To derive substantive, meaningful constructs or labels for the discriminant functions, the factor structure matrix describing the correlations between the *TISCM* components and the discriminant functions was examined. The largest absolute correlations for Function 1 were mainly with most components in Phases 2 and 3; thus, Function 1 was labeled, *Delivering instruction and integrating technology with learning*. The largest absolute correlations for Function 2 were mainly with some components in Phase 1; thus Function 2 was labeled, *Using technology as a tool for professional productivity.*

Figure 1 provides a scatter plot of the discriminant functions for each of the *TISCM* groups. Group 1 is characterized by a high positive relationship to Function 2 and a high negative relationship to Function 1, Group 2 by low positive relationship with Function 1 and a low to high negative relationship with Function 2, and Group 3 by high positive relationship to Function 1 and a low to high positive relationship with Function 2.

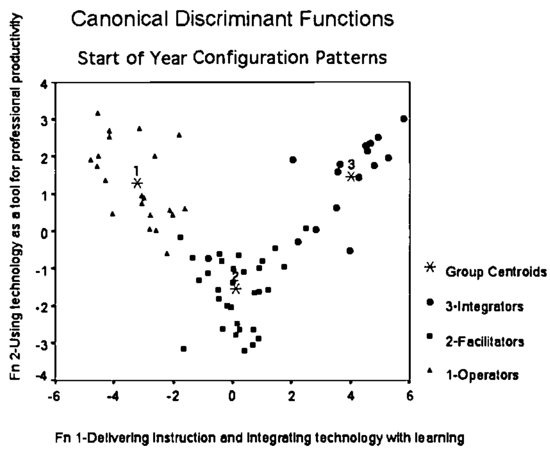

Figure 1. Scatter Plot of Discriminant Functions for Start of Year TISCM Configuration Patterns (N=70).

These configuration patterns indicated that using technology as a tool for professional productivity and operations of computer technology (Phase 1 Standards) was not necessarily a distinguishing characteristic of expertise in technology integration. In other words, there was pervasive use of computers by teachers in preparing for instruction, but limited use of computers by teachers for delivering instruction and integrating technology in the classroom. What discriminated between integrators and operators was integration skills, not operations skills.

This finding had relevance for the provision of technology professional development activities indicating to us that technology training activities needed to focus more on instructional strategies and methods to integrate technology into student learning than on activities to increase skills in using computer hardware and software applications. Although we could not ignore the novice skills associated with technology operations, our approach to training became one in which integration skills became embedded in operations training.

BEST COPY AVAILABLE

Frequency counts for *TISCM* checklist responses were analyzed to determine the attributes of each configuration pattern group based on the *TISCM* components and phases. When all the cases were summarized by group membership based on the overall technology integration rating, the classification of cases derived from the responses to the *TISCM* checklist allowed for a grouping similar to the developmental stages of the technology professional development model. Group 3 teachers demonstrated expertise in technology integration for all sub-scales; Group 2 demonstrated expertise in Phase 1 and Phase 2; and Group 1 demonstrated expertise in Phase 1 only (see Table 2).

Table 2. Descriptive Statistics of Groups by Sub-Scale/Total Scale Scores—Start of Year

GROUP		Overall Integration Score	Overall Integration Rating	Technology Operations Score	Technology Facilitation Score	Technology Integration Score
1	N	21				
	Mean	23.29	1.76	15.76	5.62	1.90
	Std. Deviation	6.54	.44	3.60	3.50	1.73
2	N	33				
	Mean	37.24	2.58	17.00	12.33	7.91
	Std. Deviation	6.09	.50	3.91	2.22	3.09
3	N	16				
	Mean	58.31	3.75	22.19	18.94	17.13
	Std. Deviation	5.62	.45	2.32	2.08	3.96
All	N	70				
	Mean	37.87	2.60	17.81	11.83	8.21
	Std. Deviation	14.08	.86	4.25	5.51	6.27

<u>End of Year Data Collection</u>

A cluster analysis was performed on the end of year data collection with the number of clusters set at 3 to compare with the patterns from the first of year data collection. With the number of clusters set at 3, the number of cases in Group 1 was 16, Group 2 was 34, and Group 3 was 28. The DA was repeated for the end of year data collection of the *TISCM* checklist and as a result of this procedure 95% of the cases or 74 of 78 cases were correctly classified. The DA predicted 4 cases in Group 3 for Group 2.

The factor structure matrix describing the correlations between the *TISCM* components and the discriminant functions was examined and the largest absolute correlations for Function 1 and Function 2 were similar in meaning to the Start of Year functions; thus Functions 1 and 2 were labeled the same as the Start of Year functions.

Figure 2 provides a scatter plot of the discriminant functions for each of the *TISCM* groups. When compared with the start of year data collection, the scatter plot indicated some dramatic movement among the participants in the development of technology integration expertise. This movement indicated changes in the substantive meaning of each group. Group 1 was characterized by a high negative relationship to Function 1 and a low negative relationship to Function 2, Group 2 by a low positive relation with Function 1 and high positive relationship to Function 2, and Group 3 by a high positive relationship to Function 1 and a relationship to Function 2 that was quite widespread from high negative to high positive.

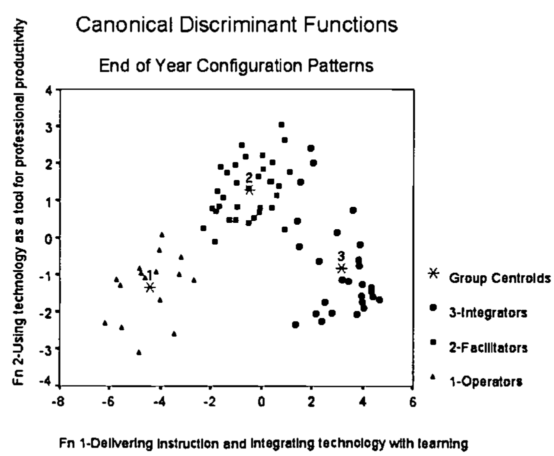

Figure 2. Scatter Plot of Discriminant Functions for End of Year TISCM Configuration Patterns (N=78).

The DA for the end of year configuration patterns demonstrated that the characteristics delineating differences among the teachers were more sharply defined by those who were novice users (or operators) and those who were facilitators and integrators of classroom technology.

Although the technology professional development initiative did not purport to make technology integrators out of all participants, the numbers of those who were facilitators and integrators were increased and their distinction from novice users was clearly indicated. Therefore, it was clear that teachers were progressing toward expertise in technology integration knowledge and skills.

When all the cases were summarized by group membership based on the overall technology integration rating, the cases of Group 1 consisted of ratings of 1's (2), 2's (13) and 3's (1); the cases of Group 2 consisted of ratings of 2's (2), 3's (27), and 4's (5); and, the cases of Group 3 consisted of ratings of 3's (3) and 4's (25). At the end of the year the classification of cases derived from the mean scores of the responses to the *TISCM* checklist strongly indicated a grouping similar to the developmental stages (phases) of the *TISCM* where Group 3 teachers demonstrated expertise in technology integration for all sub-scales, Group 2 demonstrated expertise in Phase 1 and Phase 2, and Group 1 demonstrated expertise in Phase 1 only (see Table 3).

Table 3. Descriptive Statistics of Groups by Sub-Scale/Total Scale Scores—End of Year

GROUP		Overall Integration Score	Overall Integration Rating	Technology Operations Score	Technology Facilitation Score	Technology Integration Score
1	N	16				
	Mean	28.63	1.97	19.88	5.69	3.06
	Std. Deviation	6.85	.44	4.32	3.36	2.32
2	N	34				
	Mean	47.56	3.09	22.38	14.44	10.74
	Std. Deviation	6.05	.45	2.50	3.15	2.85
3	N	28				
	Mean	60.46	3.89	22.64	21.89	15.93
	Std. Deviation	5.36	.31	2.26	2.06	4.11
All	N	78				
	Mean	48.31	3.14	21.96	15.32	11.03
	Std. Deviation	13.02	.82	3.04	6.58	5.69

Paired samples t-test for each of components (technology standards) of the *TISCM* were computed for matched cases (N=46) on the start and end of year administrations of the *TISCM* checklist. All components of the *TISCM* indicated significant differences on the t-test ($p<.05$) between the start and end of year administrations of the *TISCM* checklist except for Component 8, Component 9, and Component 16 (see Technology Standards on Table 1). Additionally, paired samples t-tests were computed for matched cases (N=46) on the start and end of year administrations. When *TISCM* components were grouped by phase, significant differences on the t-test ($p<.05$) were indicated for all three phases. These comparisons indicated measurable progress in technology integration across components and through the developmental phases.

CONCLUSIONS

A fourth grade teacher reported that at the beginning of this initiative "teachers with little experience using technology were hesitant," but, as the initiative progressed, teachers "started to bond and complete phase projects together as a support for one another." A fifth grade teacher noted an increased level of comfort using technology in classroom lesson and a high level of support from other teachers. A middle school science teacher reported integrating new technology skills and knowledge in her science lab and modifying her classroom instructional strategies to the extent that technology now plays an important role in daily instruction. A kindergarten teacher developed a PowerPoint template that was adopted for use by all the district kindergarten teachers. A high school language arts teacher worked with another teacher's class to develop a Web page for their mock business.

The common thread in these reports is that teachers are attempting to "be the technology." As teachers advanced through the developmental stages of technology integration, they began to realize that technology is more than a teaching tool and start using technology to create learning environments that augment student learning.

The results of the data analysis confirmed our perception that technology integration is a developmental process. It also supported our view that this process starts with novice teachers using technology as a tool for professional productivity and expands from there. These results also suggest that when educational best practices for teaching and learning with technology are clearly defined and established, the professional skills of teachers will begin to exemplify the stated expectations.

The results of this evaluation may have implications for Colleges of Education and teacher preparation programs. This study suggests that developing technology integration expertise in teachers will not be achieved through the provision of a technology course or two built into the professional education curriculum. Preparing new teachers who are technology integrators will require a professional education curriculum that is infused with opportunities for teacher candidates to learn with technology and model technology use throughout their professional preparation.

Over time we have refined our technology integration professional development model to include more powerful technology integration strategies in classrooms beyond that of computer technology use and operations. We have learned that through the establishment of a well-defined set of pedagogical standards and indicators, higher levels of technology integration in classrooms can be identified and achieved. Consequently, when teachers know how to use and then actually use all the tools at their disposal, the potential for student learning is increased.

Recommendations for Future Research and Development

Research is now needed to show us not only how teachers are developing expert teaching practices, but also to show us if students are achieving the outcomes these practices are designed to produce. We recommend research that focuses on learner outcomes resulting from the teaching practices and instructional strategies (student-centered, situated, cooperative, project-based, problem-solving, etc.) made possible by the expert technology integration practices described in this model.

This technology professional development model is an on-going initiative in this school district. At this writing the researchers are continuing to collect data in this school district by applying the *TISCM* model to interviewing and observational methodologies that will triangulate the results of our analyses as well as enhance our understanding of technology integration in classrooms. Additionally, the researchers are currently experimenting with phases of technology integration beyond those described in this article that will define school and district leadership in technology integration.

REFERENCES

Becker, H.J. (1994). How exemplary computing-using teachers differ from other teachers: implication for realizing the potential of computers in schools. *Journal of Research on Computer in Education 26*(3), 291-321.

Cuban, L. (2001). *Oversold and underused: Computers in the classroom.* Cambridge, MA: Harvard University Press.

Dockstader, J. (1999). Teachers of the 21st century know the what, why, and how of technology integration. *T.H.E. Journal, 26*(6), 73-74.

Hadley, M., & Sheingold, K. (1993). Commonalities and distinctive patterns in teachers' integration of computers. *American Journal of Education, 101*, 261-315.

Hall, G.E., Wallace, R.D., & Dossett, W.A. (1973). A developmental conceptualization of the adoption process within educational institutions. Austin, TX: Research and Development Center for Teacher Education, University of Texas.

Heck, S, Steigelbauer, S.M., Hall, G.E. & Loucks, S.F. (1981). *Measuring innovation configurations: Procedures and applications.* Austin, TX: Research and Development Center for Teacher Education, University of Texas.

Mills, S.C. & Ragan, T.J. (2000). A tool for analyzing implementation fidelity of an integrated learning system. *Educational Technology Research and Development Journal, 48*(4).

Mills, S.C. (2001-2002). The technology implementation standards configuration matrix: A tool for analyzing technology integration. *National Forum of Applied Educational Research Journal, 14*(2).

Pierson, M.E. (2001). Technology integration practice as a function of pedagogical expertise. *Journal of Research on Computing in Education 33*(4), 413-430.

Sandholtz, J. H., Ringstaff, C., & Dwyer, D. C. (1997). Teaching with technology: Creating student-centered classrooms. New York: Teachers College Press.

Sheingold, K. (1990). Restructuring for learning with technology. The potential for synergy. In K. Sheingold & M Tacher (Eds.), *Restructuring for learning with technology*, (pp. 9-27). New York: Bank Street College of Education: Center for Technology in Education.

Surry, D.W. (1997). Diffusion theory and instructional technology. Paper presented at the Annual Conference of the Association for Educational Communications and Technology, Albuquerque, NM.

NOTICE

Reproduction Basis

- [X] This document is covered by a signed "Reproduction Release (Blanket)" form (on file within the ERIC system), encompassing all or classes of documents from its source organization and, therefore, does not require a "Specific Document" Release form.

- [ ] This document is Federally-funded, or carries its own permission to reproduce, or is otherwise in the public domain and, therefore, may be reproduced by ERIC without a signed Reproduction Release form (either "Specific Document" or "Blanket").